

5 What is claimed is:

6 1. A method for quickly and reliably transmitting a byte stream from a sending node  
7 having a number of credits with an established connection to a receiving node in a  
8 communication environment having a plurality of nodes and a plurality of  
9 interconnectable paths, the method comprising:  
10 transmitting a predetermined number of bytes of a byte stream from a sending node  
11 to a receiving node, said predetermined number of bytes corresponding to the  
12 number of credits present at said sending node;  
13 transmitting a predetermined number of credits from said receiving node to said  
14 sending node when a predetermined event occurs; and  
15 transmitting a predetermined number of negative acknowledgements from said  
16 receiving node to said sending node, when at least one transmitted byte is lost or  
17 corrupted.

1 2. The method of claim 1, further including the step of retransmitting at least once, from  
2 said sending node to said receiving node, said lost or corrupted bytes corresponding to  
3 said predetermined number of negative acknowledgments received at said sending  
4 node.

1 3. The method of claim 1, wherein said step of transmitting said predetermined number  
2 of credits from said receiving node to said sending node occurs before the transmission  
3 of said predetermined number of bytes of said byte stream.

1 4. The method of claim 3, wherein said step of transmitting of said predetermined  
2 number of credits occurs during a connection establishment of said sending node and  
3 said receiving node.

1 5. The method of claim 3, wherein said step of transmitting of said predetermined  
2 number of credits occurs after a connection establishment of said sending node and said  
3 receiving node.

1 6. The method of claim 1, wherein said predetermined event is one from the group of a)  
2 a predetermined number of bytes from said byte stream is received at said receiving  
3 node, b) a predetermined number of bytes from said byte stream is received at said  
4 receiving node and a congestion indicator at said receiver node is less than a  
5 predetermined threshold, c) a predetermined number of bytes from said byte stream is  
6 received at said receiving node and a data error indicator at said receiver node is less  
7 than a predetermined threshold, d) a buffer at said receiving node, containing said bytes  
8 transmitted from said sending node to said receiving node, has free space, e) a buffer at  
9 said receiving node, containing said bytes transmitted from said sending node to said  
10 receiving node, has free space and a congestion indicator at said receiver node is less  
11 than a predetermined threshold, and f) a buffer at said receiving node, containing said  
12 bytes transmitted from said sending node to said receiving node, has free space and a  
13 data error indicator at said receiver node is less than a predetermined threshold.

1 7. The method of claim 1, wherein the reception of said credits at said receiving node  
2 indicates that at least a subset of said byte stream was correctly received at said  
3 receiving node.

1 8. The method of claim 1, wherein said step of transmitting of said predetermined  
2 number of credits is dependent upon a counter exceeding a predetermined number  
3 representative of received bytes at said receiving node, said transmitting step including  
4 the steps of:  
5 transmitting a predetermined number of credits from said receiving node to said  
6 sending node when said counter is equal to at least a predetermined value; and  
7 decrementing said counter by said byte size upon transmission of said credits.

1 9. The method of claim 1, wherein said credits from said credit transmission step are  
2 reduced or delayed to reflect congestion detection in an established connection.

1 10. The method of claim 1, wherein said step of transmitting of said predetermined  
2 number of bytes is dependent upon a counter exceeding a predetermined number  
3 representative of received credits at said sending node, said transmitting step including  
4 the steps of:  
5 transmitting said bytes from said sending node to said receiving node when said  
6 counter is equal to at least said number of bytes; and  
7 decrementing said counter by said number of bytes upon said transmission of said  
8 bytes.

1 11. The method of claim 1, wherein said bytes transmitted in said byte transmission  
2 step are in the form of Transmission Control Protocol (TCP) packets, whereby said  
3 method is compatible at the application programming level of TCP.

1 12. The method of claim 1, wherein the established connection between said sending  
2 node and said receiving node is established using the standard 3-way handshake of  
3 Transmission Control Protocol (TCP).

1 13. The method of claim 1, further including the step of resetting said established  
2 connection when said transmission of at least one of said negative acknowledgements  
3 occurs a predetermined number of times.

1 14. The method of claim 1, wherein said transmitting of said predetermined number of  
2 credits occurs by piggybacking existing traffic with said credits from said receiving  
3 node to said sending node.

1 15. The method of claim 1, wherein said credits in said credit transmission step are not  
2 retransmitted if they are lost.

1 16. The method of claim 1, wherein said predetermined number of negative  
2 acknowledgements is transmitted at predetermined events.

1 17. The method of claim 1, wherein said at least one corrupted byte is detected by  
2 means of error detection hardware only.

1 18. The method of claim 1, wherein said at least one corrupted byte is detected only  
2 once by software error detection means.

1 19. A method for quickly and reliably transmitting a byte stream from a sending node  
2 having credits with an established connection to a receiving node in a communication  
3 environment having a plurality of nodes and with a plurality of interconnectable paths,  
4 where the bytes of said byte stream are formed into a plurality of data packets of a  
5 protocol, the method comprising:

6 providing a predetermined identifier associated with data packets;  
7 if said predetermined identifier indicates a credit and negative acknowledgement  
8 transport system, transmitting a predetermined number of bytes of a byte stream  
9 from a sending node to a receiving node, corresponding to the number of credits  
10 present at said sending node;  
11 transmitting a predetermined number of credits from said receiving node to said  
12 sending node when a predetermined even occurs; and  
13 transmitting a predetermined number of negative acknowledgements from said  
14 receiving node to said sending node, when at least one transmitted byte is lost or  
15 corrupted.

1 20. The method of claim 19, the step further comprising:  
2 if said predetermined identifier indicates a transport system that is not exclusively  
3 credit and negative acknowledgement based, processing  
4 said data stream by a transport system independent of credit and negative  
5 acknowledgements, whereby compatibility at the application programming level of  
6 a protocol is maintained.

1 21. The method of claim 19, the steps further comprising:  
2 providing a first packet filter for filtering data packets at a sending node;  
3 providing a second packet filter for filtering data packets at a receiving node, so  
4 that said predetermined identifier indicates a credit and negative acknowledgement  
5 transport system dependent on said first and second packet filters.

1 22. The method of claim 19, further including the step of retransmitting at least once,  
2 from said sending node to said receiving node, said lost or corrupted bytes  
3 corresponding to said predetermined number of negative acknowledgments received at  
4 said sending node.

1 23. The method of claim 19, wherein said step of transmitting said predetermined  
2 number of credits from said receiving node to said sending node occurs before the  
3 transmission of said predetermined number of bytes of said byte stream.

1 24. The method of claim 23, wherein said step of transmitting of said predetermined  
2 number of credits occurs during a connection establishment of said sending node and  
3 said receiving node.

1 25. The method of claim 23, wherein said step of transmitting of said predetermined  
2 number of credits occurs after a connection establishment of said sending node and said  
3 receiving node.

1 26. The method of claim 19, wherein said predetermined event is one from the group of  
2 a) a predetermined number of bytes from said byte stream is received at said receiving  
3 node, b) a predetermined number of bytes from said byte stream is received at said  
4 receiving node and a congestion indicator at said receiver node is less than a  
5 predetermined threshold, c) a predetermined number of bytes from said byte stream is  
6 received at said receiving node and a data error indicator at said receiver node is less  
7 than a predetermined threshold, d) a buffer at said receiving node, containing said bytes  
8 transmitted from said sending node to said receiving node, has free space, e) a buffer at  
9 said receiving node, containing said bytes transmitted from said sending node to said  
10 receiving node, has free space and a congestion indicator at said receiver node is less  
11 than a predetermined threshold, and f) a buffer at said receiving node, containing said  
12 bytes transmitted from said sending node to said receiving node, has free space and a  
13 data error indicator at said receiver node is less than a predetermined threshold.

1 27. The method of claim 19, wherein the reception of said credits at said receiving node  
2 indicates that at least a subset of said byte stream was correctly received at said  
3 receiving node.

1 34. The method of claim 19, wherein said transmitting of said predetermined number of  
2 credits occurs by piggybacking existing traffic with said credits from said receiving  
3 node to said sending node.

1 35. The method of claim 19, wherein said credits in said credit transmission step are not  
2 retransmitted if they are lost.

1 36. The method of claim 19, wherein said predetermined number of negative  
2 acknowledgements is transmitted at predetermined events.

1 37. The method of claim 19, wherein said at least one corrupted byte is detected by  
2 means of error detection hardware only.

1 38. The method of claim 19, wherein said at least one corrupted byte is detected only  
2 once by software error detection means.

1 39. A system for quickly and reliably transmitting a byte stream from a sending node  
2 having credits with an established connection to a receiving node in a communication  
3 environment having a plurality of nodes with a plurality of interconnectable paths,  
4 comprising:  
5 means for transmitting a predetermined number of bytes of a byte stream from a  
6 sending node to a receiving node, said predetermined number of bytes  
7 corresponding to the number of credits present at said sending node;  
8 means for transmitting a predetermined number of credits from said receiving node  
9 to said sending node when a predetermined event occurs; and  
10 means transmitting a predetermined number of negative acknowledgements from  
11 said receiving node to said sending node, when at least one transmitted byte is lost  
12 or corrupted.

1 40. The system of claim 39, further comprising:  
2 means for retransmitting at least once, from said sending node to said receiving  
3 node, said lost or corrupted bytes corresponding to said predetermined number of  
4 negative acknowledgments received at said sending node.

1 41. The system of claim 39, further comprising:  
2 means for transmitting said predetermined number of credits from said receiving  
3 node to said sending node occurs before the transmission of said predetermined  
4 number of bytes of said byte stream.

1 42. The system of claim 41, wherein said means for transmitting of said predetermined  
2 number of credits occurs during a connection establishment of said sending node and  
3 said receiving node.

1 43. The system of claim 41, wherein said means for transmitting of said predetermined  
2 number of credits occurs after a connection establishment of said sending node and said  
3 receiving node.

1 44. The system of claim 39, wherein said predetermined event is one from the group of  
2 a) a predetermined number of bytes from said byte stream is received at said receiving  
3 node, b) a predetermined number of bytes from said byte stream is received at said  
4 receiving node and a congestion indicator at said receiver node is less than a  
5 predetermined threshold, c) a predetermined number of bytes from said byte stream is  
6 received at said receiving node and a data error indicator at said receiver node is less  
7 than a predetermined threshold, d) a buffer at said receiving node, containing said bytes  
8 transmitted from said sending node to said receiving node, has free space, e) a buffer at  
9 said receiving node, containing said bytes transmitted from said sending node to said  
10 receiving node, has free space and a congestion indicator at said receiver node is less  
11 than a predetermined threshold, and f) a buffer at said receiving node, containing said  
12 bytes transmitted from said sending node to said receiving node, has free space and a  
13 data error indicator at said receiver node is less than a predetermined threshold.

1 45. The system of claim 39, wherein the reception of said credits at said receiving node  
2 indicates that at least a subset of said byte stream was correctly received at said  
3 receiving node.

1 46. The system of claim 39, wherein said means for transmitting of said predetermined  
2 number of credits is dependent upon a counter exceeding a predetermined number  
3 representative of received bytes at said receiving node, said transmitting means  
4 comprising:  
5 means for transmitting a predetermined number of credits from said receiving node  
6 to said sending node when said counter is equal to at least a predetermined value;  
7 and  
8 means for decrementing said counter by said byte size upon transmission of said  
9 credits.



1 47. The system of claim 39, wherein said credits from said means for credit  
2 transmission are reduced or delayed to reflect congestion detection in an established  
3 connection.

1 48. The system of claim 39, wherein said means for transmitting of said predetermined  
2 number of bytes is dependent upon a counter exceeding a predetermined number  
3 representative of received credits at said sending node, said transmitting means  
4 comprising:

5 means for transmitting said bytes from said sending node to said receiving node  
6 when said counter is equal to at least said number of bytes; and  
7 means for decrementing said counter by said number of bytes upon said  
8 transmission of said bytes.

1 49. The system of claim 39, wherein said bytes transmitted by said byte transmission  
2 means are in the form of Transmission Control Protocol (TCP) packets, whereby said  
3 system is compatible at the application programming level of TCP.

1 50. The system of claim 39, wherein the established connection between said sending  
2 node and said receiving node is established using the standard 3-way handshake of  
3 Transmission Control Protocol (TCP).

1 51. The system of claim 39, further comprising:  
2 means for resetting said established connection when said transmission of at least  
3 one of said negative acknowledgements occurs a predetermined number of times.

1 52. The system of claim 39, wherein said means for transmitting of said predetermined  
2 number of credits occurs by piggybacking existing traffic with said credits from said  
3 receiving node to said sending node.

1 53. The system of claim 39, wherein said credits in said credit transmission means are  
2 not retransmitted if they are lost.

1 54. The system of claim 39, wherein said predetermined number of negative  
2 acknowledgements is transmitted at predetermined events.

1 55. The system of claim 39, wherein said at least one corrupted byte is detected by  
2 means of error detection hardware only.

1 56. The system of claim 39, wherein said at least one corrupted byte is detected only  
2 once by software error detection means.

1 57. A system for quickly and reliably transmitting a byte stream from a sending node  
2 having credits with an established connection to a receiving node in a communication  
3 environment having a plurality of nodes and with a plurality of interconnectable paths,  
4 where the bytes of said byte stream are formed into a plurality of data packets of a  
5 protocol, the system comprising:  
6 a predetermined identifier associated with data packets;  
7 means for transmitting a predetermined number of bytes of a byte stream from a  
8 sending node to a receiving node, corresponding to the number of credits present at  
9 said sending node, if said predetermined identifier indicates a credit and negative  
10 acknowledgement transport system;  
11 means for transmitting a predetermined number of credits from said receiving node  
12 to said sending node when a predetermined even occurs; and  
13 means for transmitting a predetermined number of negative acknowledgements  
14 from said receiving node to said sending node, when at least one transmitted byte is  
15 lost or corrupted.

1 58. The system of claim 57, further comprising:  
2 means for processing said data stream by a transport system independent of credit  
3 and negative acknowledgements, if said predetermined identifier indicates a  
4 transport system that is not exclusively credit and negative acknowledgement  
5 based, whereby compatibility at the application programming level of a protocol is  
6 maintained.

1 59. The system of claim 57, further comprising:  
2 a first packet filter for filtering data packets at a sending node;  
3 a second packet filter for filtering data packets at a receiving node, so that said  
4 predetermined identifier indicates a credit and negative acknowledgement transport  
5 system dependent on said first and second packet filters.

1 60. The system of claim 57, further comprising:  
2 means for retransmitting at least once, from said sending node to said receiving  
3 node, said lost or corrupted bytes corresponding to said predetermined number of  
4 negative acknowledgments received at said sending node.

1 61. The system of claim 57, further comprising:  
2 means for transmitting said predetermined number of credits from said receiving  
3 node to said sending node occurs before the transmission of said predetermined  
4 number of bytes of said byte stream.

1 62. The system of claim 61, wherein said means for transmitting of said predetermined  
2 number of credits occurs during a connection establishment of said sending node and  
3 said receiving node.

1 63. The system of claim 61, wherein said means for transmitting of said predetermined  
2 number of credits occurs after a connection establishment of said sending node and said  
3 receiving node.

1 64. The system of claim 57, wherein said predetermined event is one from the group of  
2 a) a predetermined number of bytes from said byte stream is received at said receiving  
3 node, b) a predetermined number of bytes from said byte stream is received at said  
4 receiving node and a congestion indicator at said receiver node is less than a  
5 predetermined threshold, c) a predetermined number of bytes from said byte stream is  
6 received at said receiving node and a data error indicator at said receiver node is less  
7 than a predetermined threshold, d) a buffer at said receiving node, containing said bytes  
8 transmitted from said sending node to said receiving node, has free space, e) a buffer at  
9 said receiving node, containing said bytes transmitted from said sending node to said  
10 receiving node, has free space and a congestion indicator at said receiver node is less  
11 than a predetermined threshold, and f) a buffer at said receiving node, containing said  
12 bytes transmitted from said sending node to said receiving node, has free space and a  
13 data error indicator at said receiver node is less than a predetermined threshold.

1 65. The system of claim 57, wherein the reception of said credits at said receiving node  
2 indicates that at least a subset of said byte stream was correctly received at said  
3 receiving node.

1 66. The system of claim 57, wherein said means for transmitting of said predetermined  
2 number of credits is dependent upon a counter exceeding a predetermined number  
3 representative of received bytes at said receiving node, said transmitting means  
4 comprising:  
5 means for transmitting a predetermined number of credits from said receiving node  
6 to said sending node when said counter is equal to at least a predetermined value;  
7 and  
8 means for decrementing said counter by said byte size upon transmission of said  
9 credits.

1 67. The system of claim 57, wherein said credits from said means for credit  
2 transmission are reduced or delayed to reflect congestion detection in an established  
3 connection.

1  
2 68. The system of claim 57, wherein said means for transmitting of said predetermined  
3 number of bytes is dependent upon a counter exceeding a predetermined number  
4 representative of received credits at said sending node, said transmitting means  
5 comprising:  
6 means for transmitting said bytes from said sending node to said receiving node  
7 when said counter is equal to at least said number of bytes; and  
8 means for decrementing said counter by said number of bytes upon said  
9 transmission of said bytes.

1 69. The system of claim 57, wherein said bytes transmitted by said byte transmission  
2 means are in the form of Transmission Control Protocol (TCP) packets, whereby said  
3 system is compatible at the application programming level of TCP.

1 70. The system of claim 57, wherein the established connection between said sending  
2 node and said receiving node is established using the standard 3-way handshake of  
3 Transmission Control Protocol (TCP).

1 71. The system of claim 57, further comprising:  
2 means for resetting said established connection when said transmission of at least  
3 one of said negative acknowledgements occurs a predetermined number of times.

1 76. The system of claim 57, wherein said at least one corrupted byte is detected only  
2 once by software error detection means.